

AOML-CARICOOS Underwater Glider Observations in the Caribbean Sea and Tropical North Atlantic Ocean in Support of Tropical Cyclone Studies and Forecasts

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Gustavo Jorge Goni¹ (Gustavo.Goni@noaa.gov)

Jili Dong ⁴, Ricardo Domingues ², Julio Morell³, Francis Bringas¹, George Halliwell¹, Hyun-Sook Kim⁴, Becky Baltles⁵, Richard Bouchard⁶, Luis Pomales ³, and Yamil Rodriguez⁷

1 NOAA/AOML, Miami, Florida, USA

2 University of Miami, CIMAS, Miami, Florida, USA

3 University of Puerto Rico, Mayagues, Puerto Rico, and CariCOOS

4 NOAA/EMC, College Park, Maryland, USA

5 IOOS Office, Silver Spring, MD, USA

6 NOAA/NDBC, Stennis, Miss, USA

7 ANAMAR, Santo Domingo, Dominican Republic

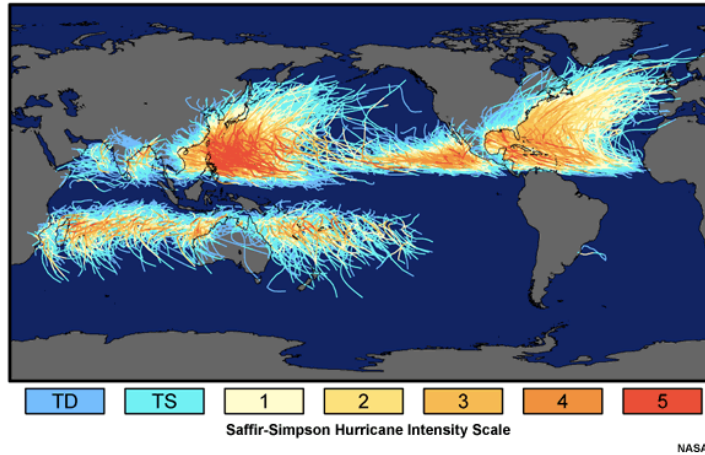
Supported by:

- Disaster Relief Appropriations Act (Sandy Supplemental funds)
- NOAA AOML
- IOOS and CARICOOS
- OAR AAA Reserve 2015 and 2016

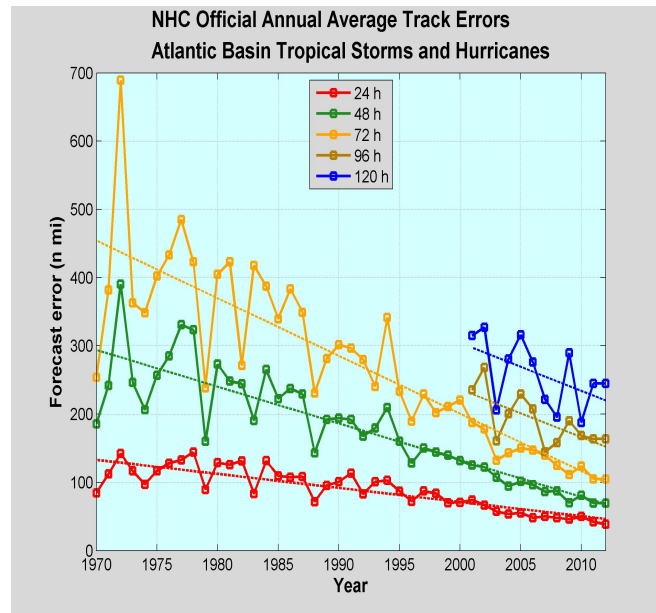


Tropical Cyclone Intensity and Track Forecasts

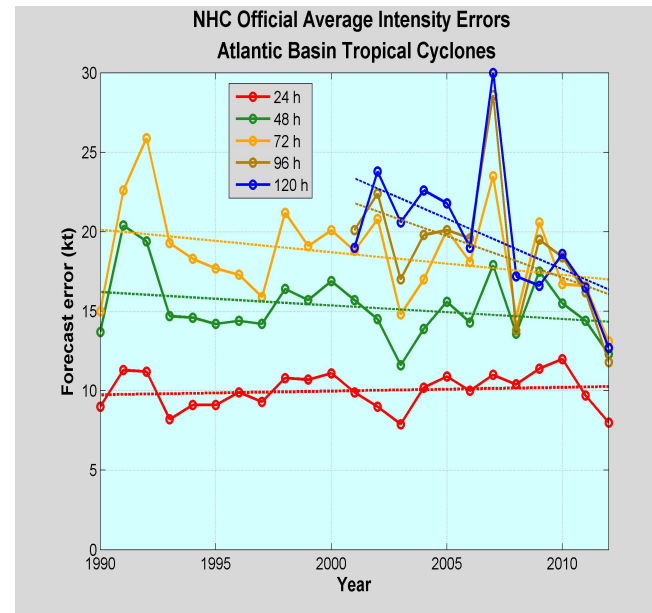
Tracks and Intensity of Tropical Cyclones, 1851-2006



Error reduction in Atlantic track forecast

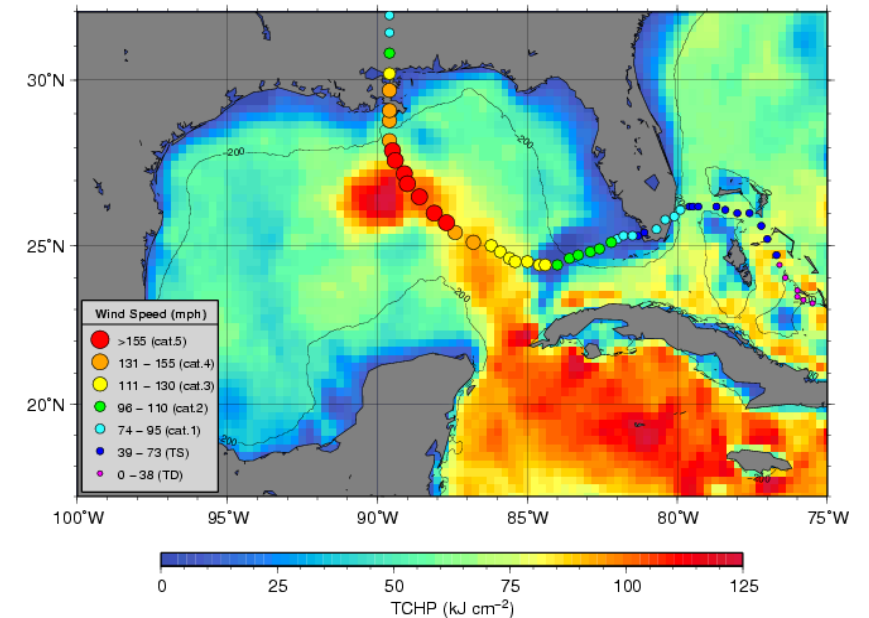


Error reduction in Atlantic intensity forecast



Tropical Cyclone Heat Potential Upper Ocean Heat Content

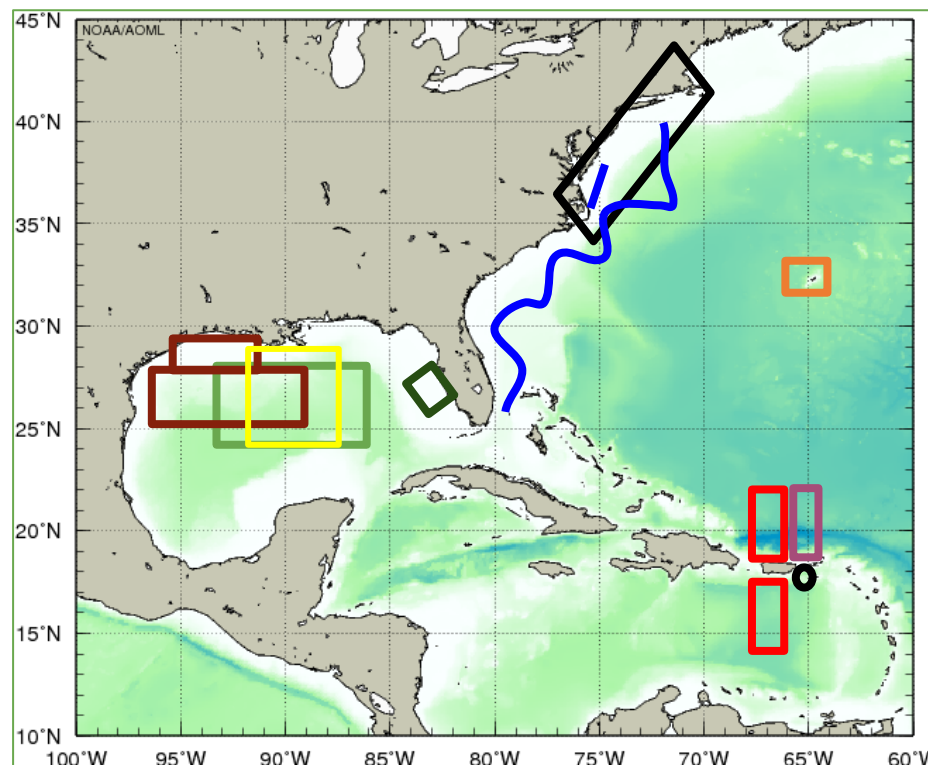
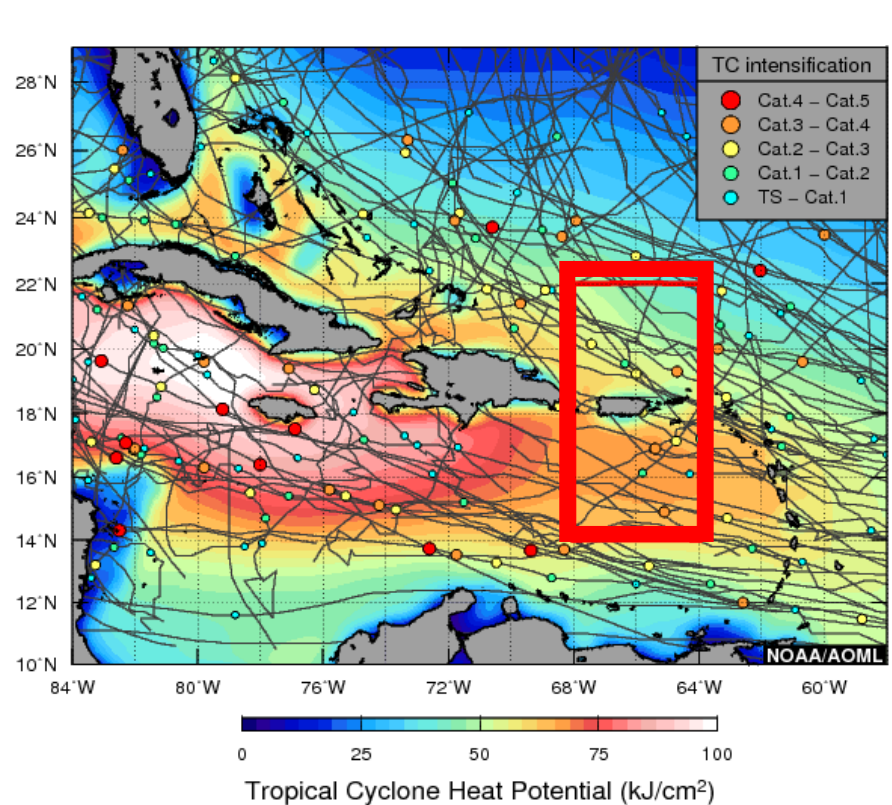
Gulf of Mexico – Tropical cyclone heat potential (TCHP) 08/28/2005



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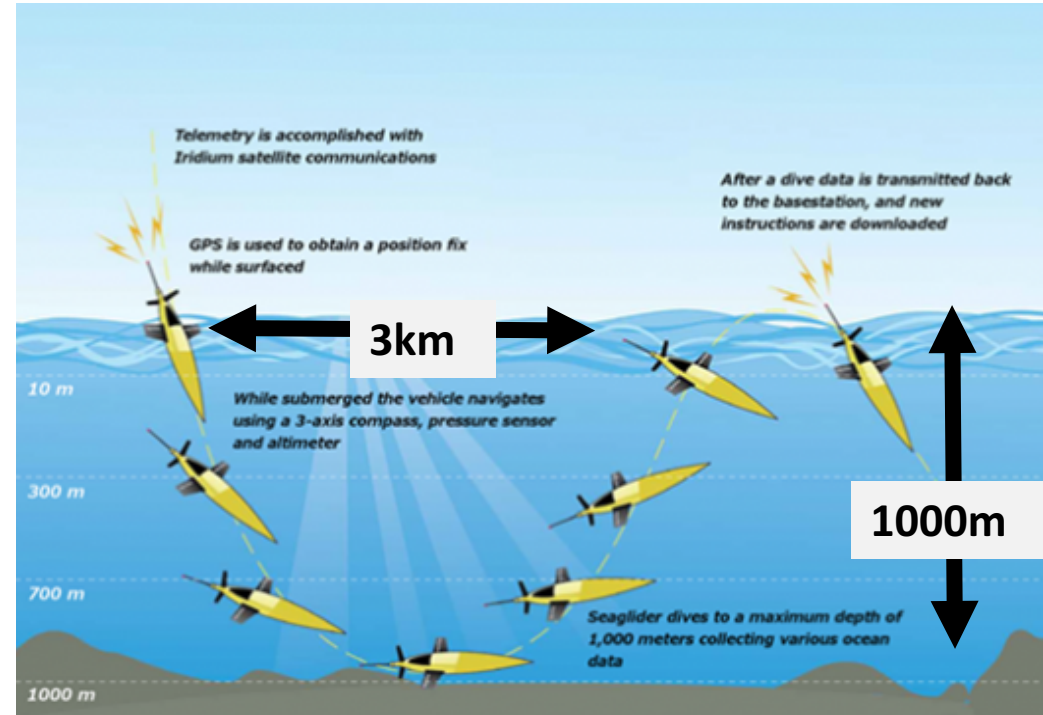
Objectives

- Assess impact of hurricane force winds on upper ocean density structure, and
- Assess impact of ocean profile data from underwater gliders in hurricane intensity forecasts.



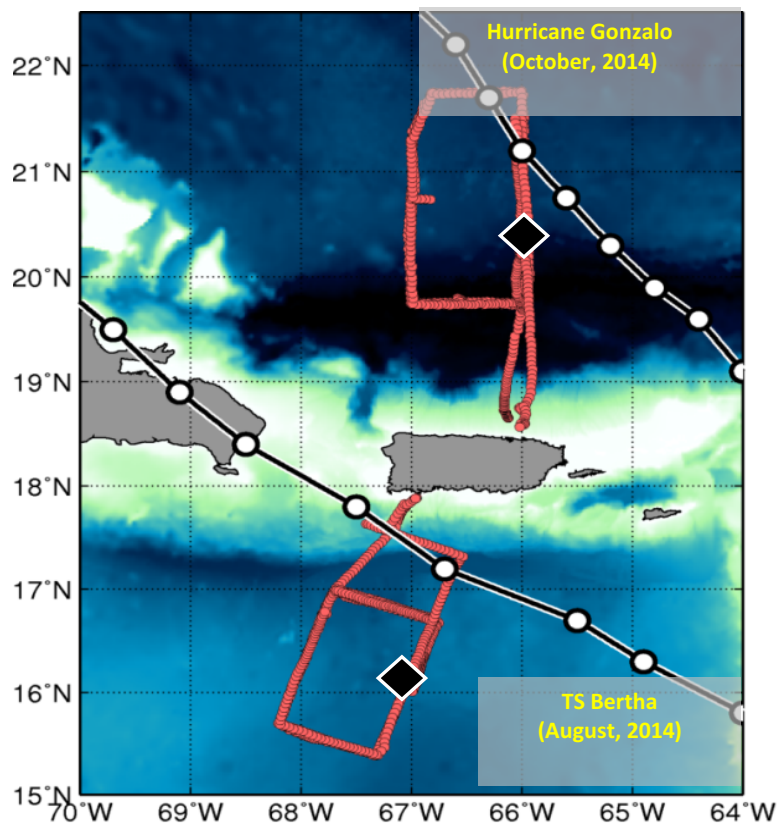
AOML-CARICOOS Underwater Glider Observations

- Autonomous Underwater Vehicle (AUV)
- Seaglider version
- Profiles of T, S, O₂, pH, CDOM, ...
- Surface and depth-average currents
- 5 dives per day to 1000 m depth
- 3 km horizontal resolution
- 15-20 km travelled per day
- 4-5 months battery life
- Operates under hurricane wind conditions
- Piloted from ground
- Real-Time data transmissions to GTS
- Data distribution through AOML and IOOS

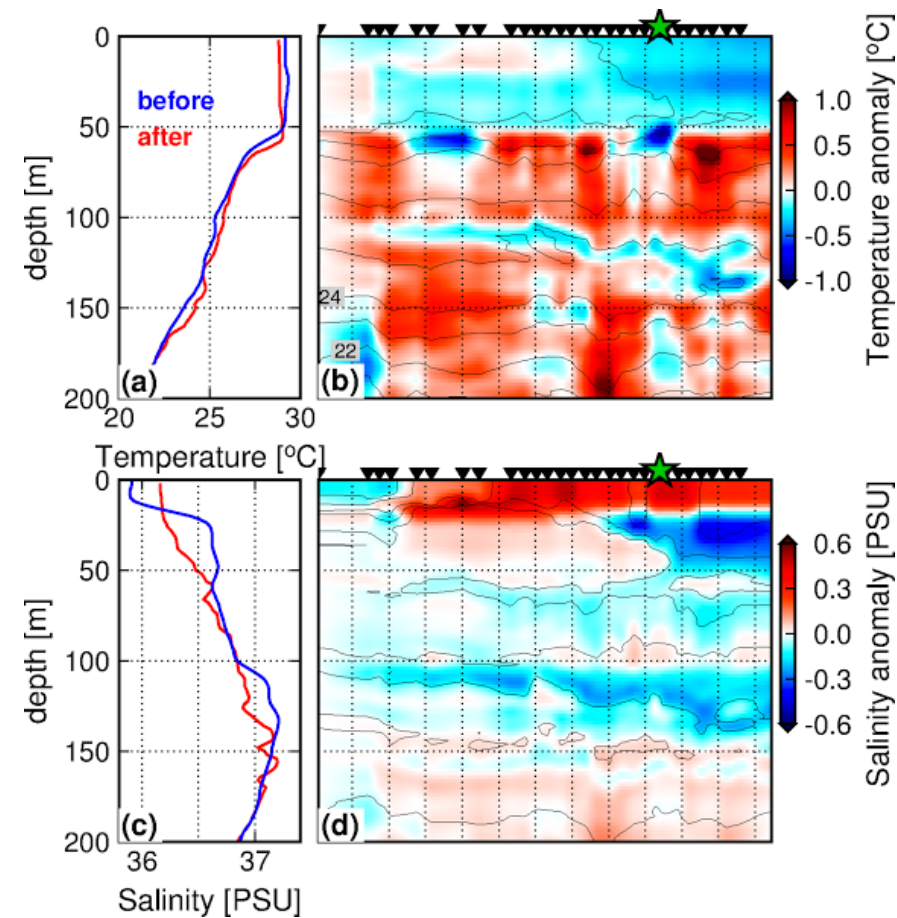
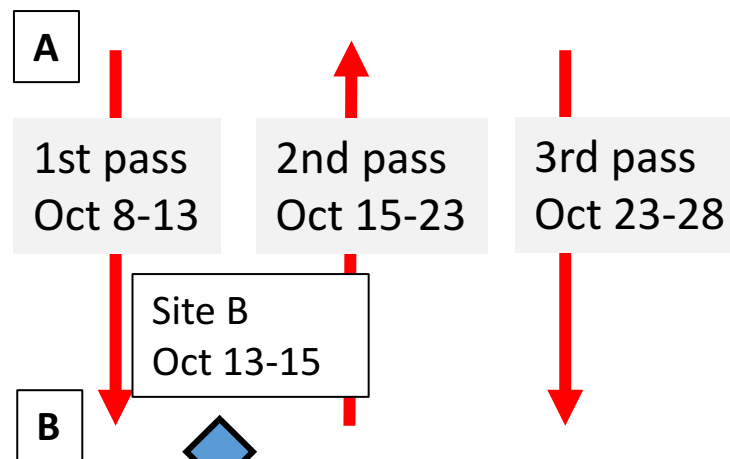


AOML-CARICOOS Underwater Glider Observations: Hurricane observations

First mission
Jul-Nov 2014



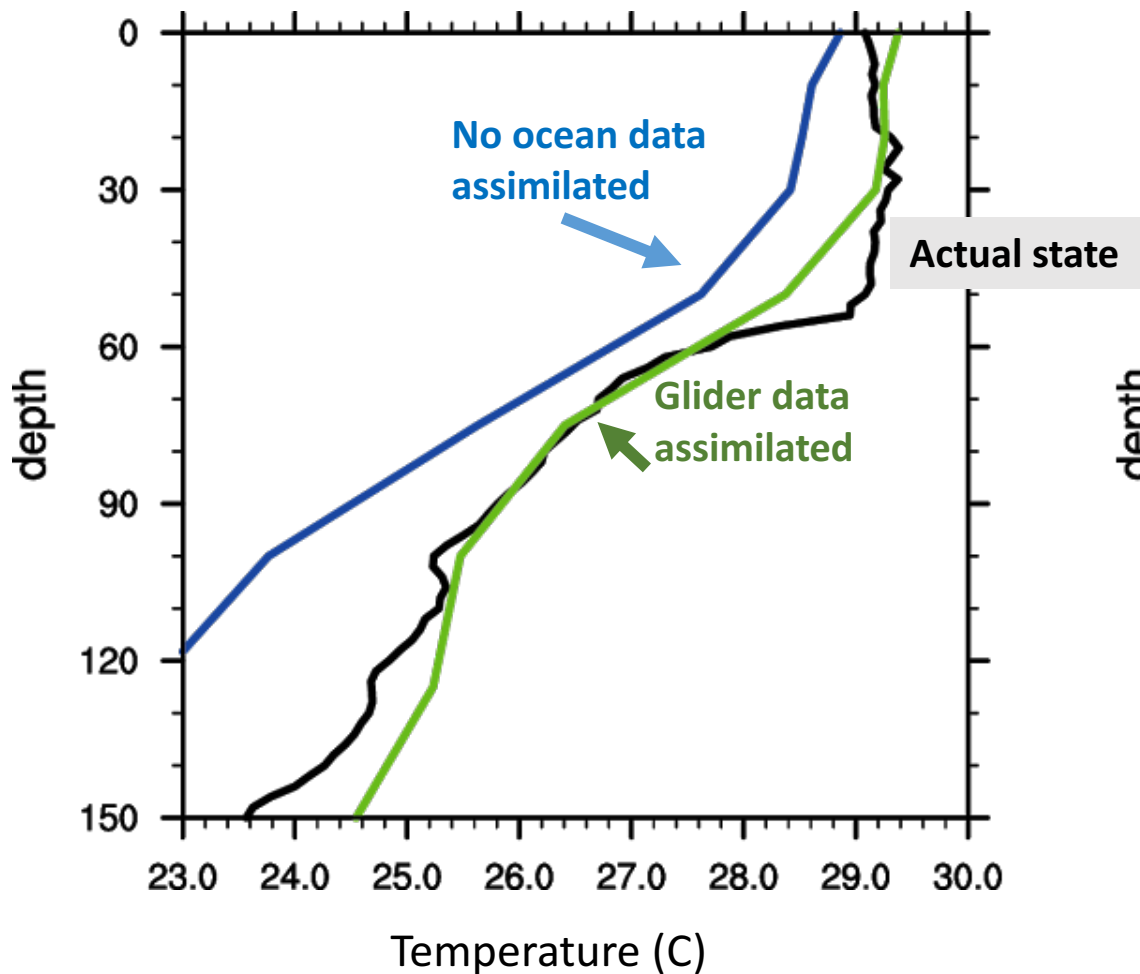
Sampling strategy



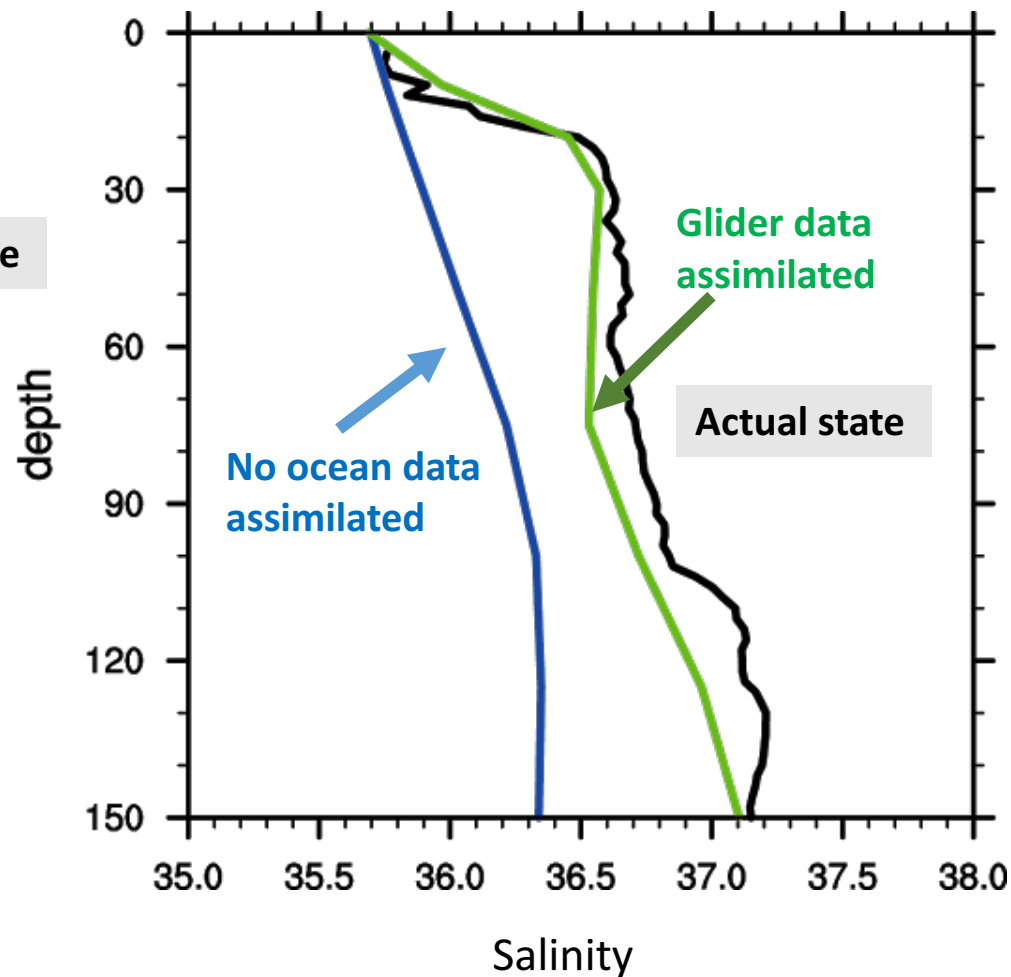
Domingues, R., G. Goni, F. Bringas, S.-K. Lee, H.-S. Kim, G. Halliwell, J. Dong, J. Morell, and L. Pomales (2015), Upper ocean response to Hurricane Gonzalo (2014): Salinity effects revealed by targeted and sustained underwater glider observations, *Geophys. Res. Lett.*, 42, doi:10.1002/2015GL065378.

Impact of glider data on HYCOM initialization (HYCOM-HWRF model run at NOAA/EMC and NOAA/AOML)

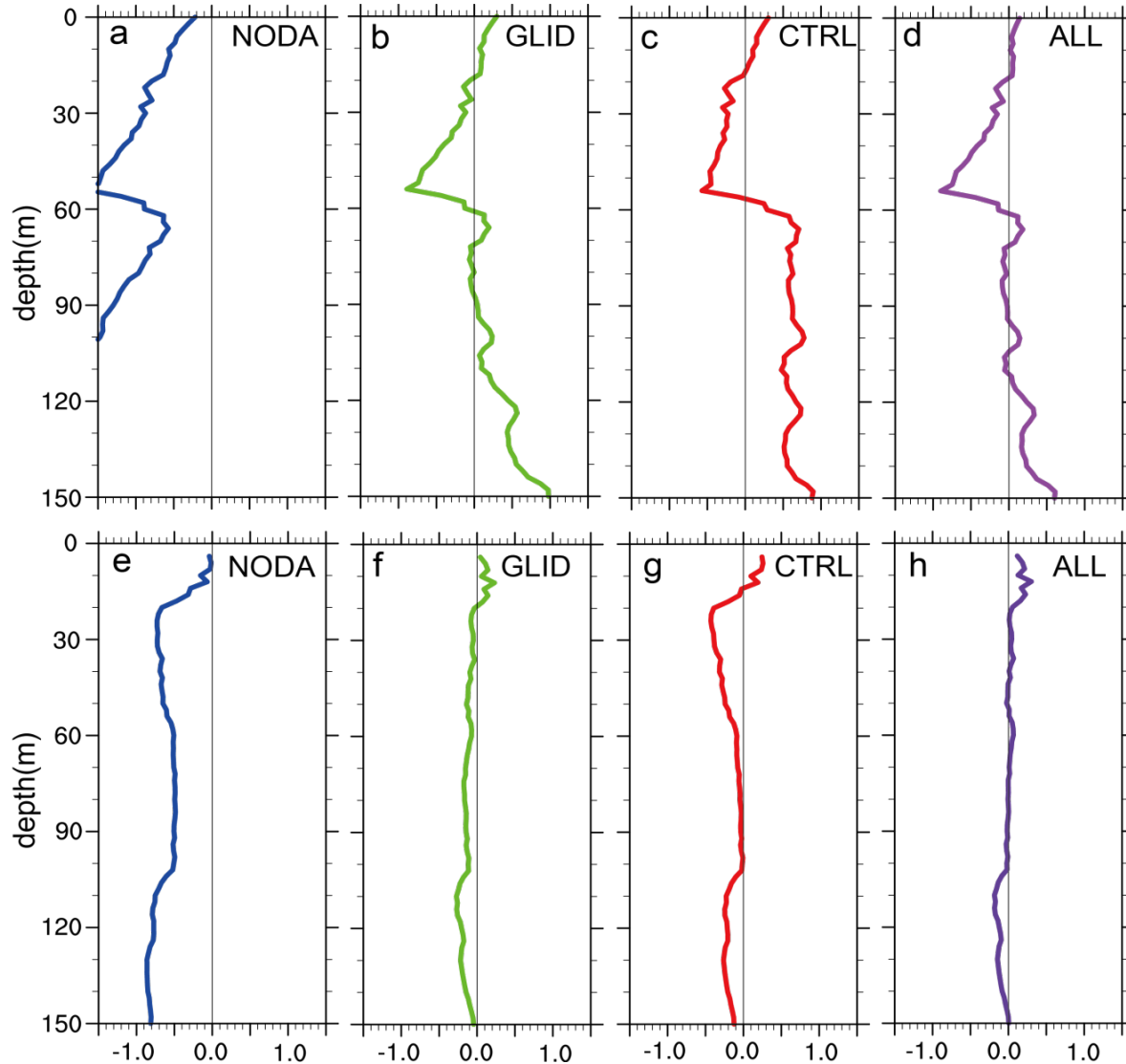
Pre-storm temperature conditions



Pre-storm salinity conditions



Impact of ocean T-S profile data on HYCOM model initialization during Hurricane Gonzalo (2014)



Difference between glider observations and HYCOM with:

HYCOM with no data assimilated

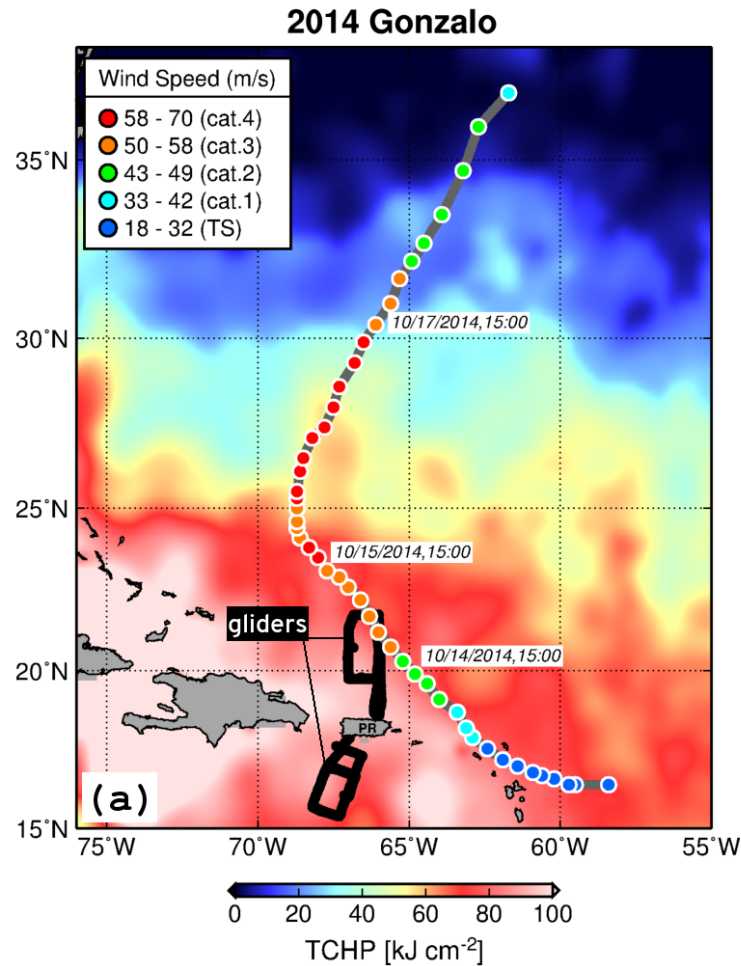
HYCOM with only glider data assimilated

HYCOM with all ocean data – gliders assimilated

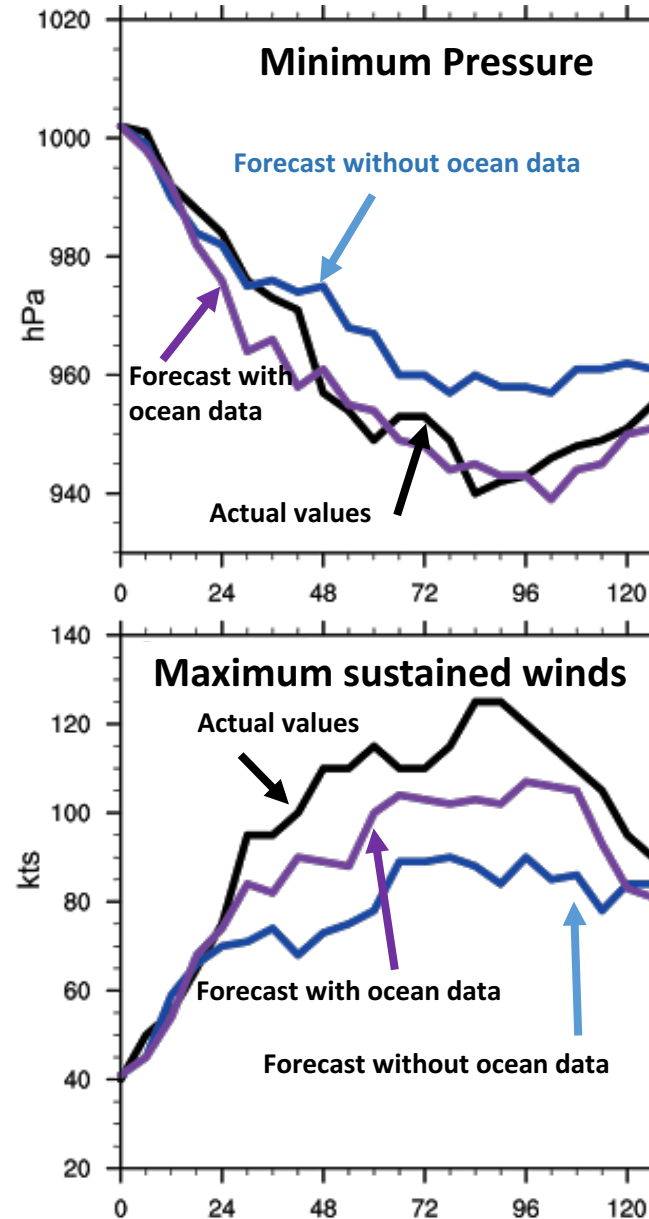
HYCOM with all ocean data assimilated

Temperature (in °C; a-d) and salinity (e-h) errors profile of four experiments (model-obs) at 00 UTC October 13 2014.

Impact of ocean data on HYCOM-HWRF intensity forecast during Hurricane Gonzalo (2014)



Hurricane Gonzalo (2014)



Upper ocean T and S profiles reduced error in intensity forecasts in 90% for Minimum Pressure and in 50% for Maximum Sustained Winds

The upper ocean density structure matters

Dong, J., R. Domingues, G. Goni, G. Halliwell, H.-S. Kim, S.-K. Lee, M. Mehari, F. Bringas, J. Morell, and L. Pomales, 2017: Impact of assimilating underwater glider data on Hurricane Gonzalo (2014) forecast. *Weather and Forecasting*, (doi:10.1175/WAF-D-16-0182.1)

Main conclusions

- Several glider missions in place in the tropical Atlantic, Caribbean Sea and Gulf of Mexico.
- Underwater gliders provide critical temperature and salinity profile data in real-time even during tropical cyclone wind conditions.
- Upper ocean low salinity layer, which often play an important role in intensification, was not adequately initialized in HYCOM model during Hurricane Gonzalo (2014). Glider data improved ocean initialization when assimilated within HYCOM-HWRF model.
- Upper ocean data reduced the error in intensity forecast of Gonzalo (2014) by up to 50%

Future work

- Continue collecting ocean profile data from underwater gliders.
- Next AOML-CARICOOS-NDBC hurricane glider deployments in July 2017.
- Most glider efforts will be communicated to NOAA/EMC and will be part of the NOAA Hurricane Field Program.
- Continue to assess the impact of underwater glider observations on intensity forecast for individual hurricanes and create long record and statistical analysis.
- Assess optimal observational strategy to improve TC intensity forecast using a suite of ocean observations.
- Continue exploring funding sources to maintain the AOML-CARICOOS-NDBC network beyond CY2017.

